A PEEK AT THE PEAK

Case Study: Reducing Seattle's Peak Water Demand

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Abstract

Lowering peak water demands can provide substantial economic benefits to utilities and their customers. A review of historical peak demand in Seattle's service area over the past decade shows a steady decline. As a result, some distribution and supply facility expansions have been postponed, saving millions of dollars in debt service and helping to reduce short term rate increases.

A wide range of peak demand reduction techniques have been applied in Seattle with varying success. These techniques can be divided into several categories: rates and price signals, internal utility measures such as non-revenue water reductions, and customer peak use reduction.

The levelized cost of meeting peak demands has been determined and is being utilized for calculating water rates and charges, establishing benchmarks for comparing conventional sources of new supply, and as a basis for setting financial incentives (rebates) for water conservation.

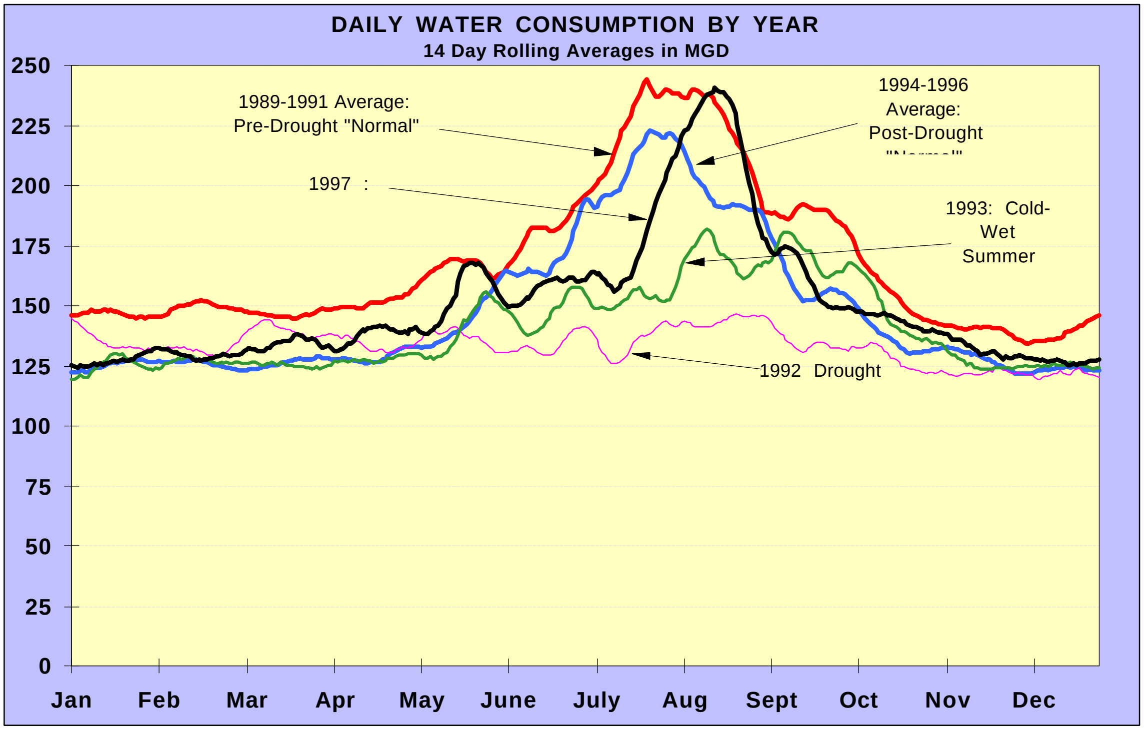
Introduction

Water conservation is typically thought of as an alternative supply source or as a technique to respond to a shortage emergency. Although the practice of peak demand management is common among electric utilities, many water utilities are unfamiliar with it. Providing enough water system capacity to meet the demands of all customers at all times is typically viewed as a necessary customer service. Unlike electricity, water can be stored, and peak demands can be met by enlarging the capacity of pumps, pipes, tanks, and reservoirs. Loss in pressure or temporary interruption of water service are considered engineering failures, and typically responded to with a structural engineering solution.

As the cost of expanding peak capacity increases, many water suppliers are searching for lower cost options. The City of Seattle's water system has calculated the incremental cost of providing expanded capacity to met peak demand, and has determined that in many instances, alternatives to traditional engineering solutions can be less expensive. Since pumps, pipes, and related infrastructure are usually sized to meet peak, rather than average demands, conservation measures that target peak demand reduction offer more value than measures that target base (average) demands.

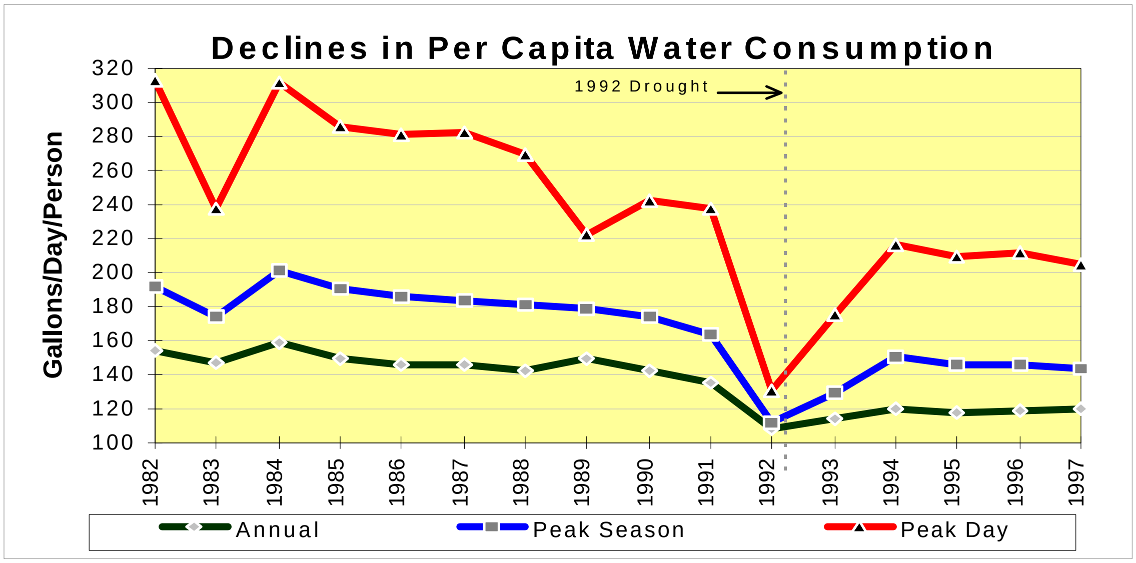
Seattle's Peak Demand Trends

In Seattle, summer season peaking can effectively double winter water demands. Irrigation of residential landscapes, especially lawns, is the cause of the high peak. Weather patterns each year provide significant variation in peak demand, with cool wet summers having much lower peaks than hot dry summers. In the 14 day rolling average graph, "Daily Water Consumption by Year", note how peak demand in a "wet" 1993 differs from pre and post drought average. Understanding multi-year peaking patterns lead Seattle to develop a weather based demand forecasting tool. This model is now being used routinely for both water management and revenue forecasting estimates.

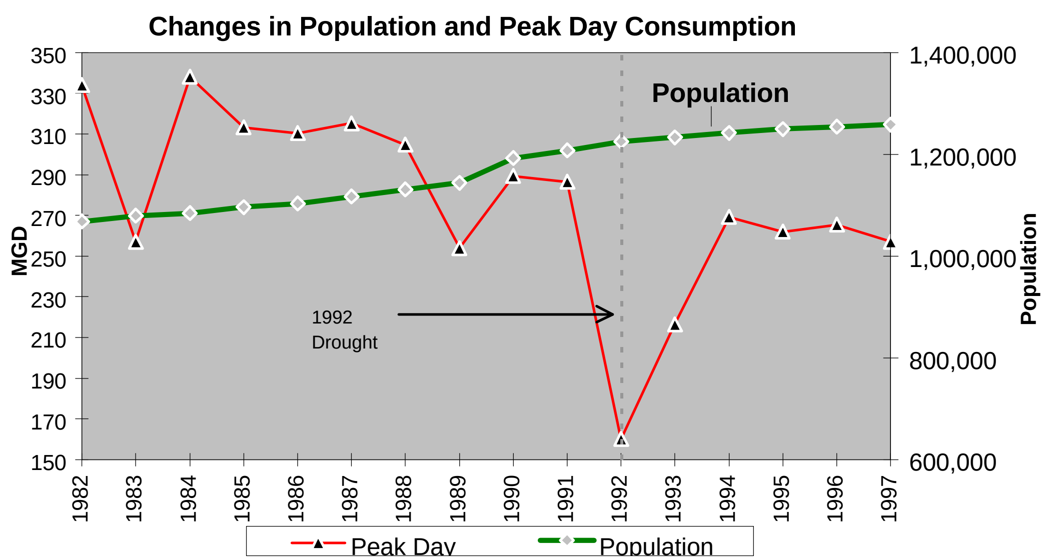


In years with a wet cool irrigation season, customer demand for water is greatly reduced. In 1992, a regional drought required a mandatory ban on lawn watering all summer, and essentially eliminated the normal peak in summer demand. While mandatory bans can be quite effective peak demand reduction tools, they are unpopular with customers and elected officials. Such bans rarely result in significant cost savings for utilities, rather , loss of revenue can be quite extensive.

Another way to track peak demand is to use peak day per capita water consumption. The following graph shows a steady and easily documented reduction trail. Note that the peak

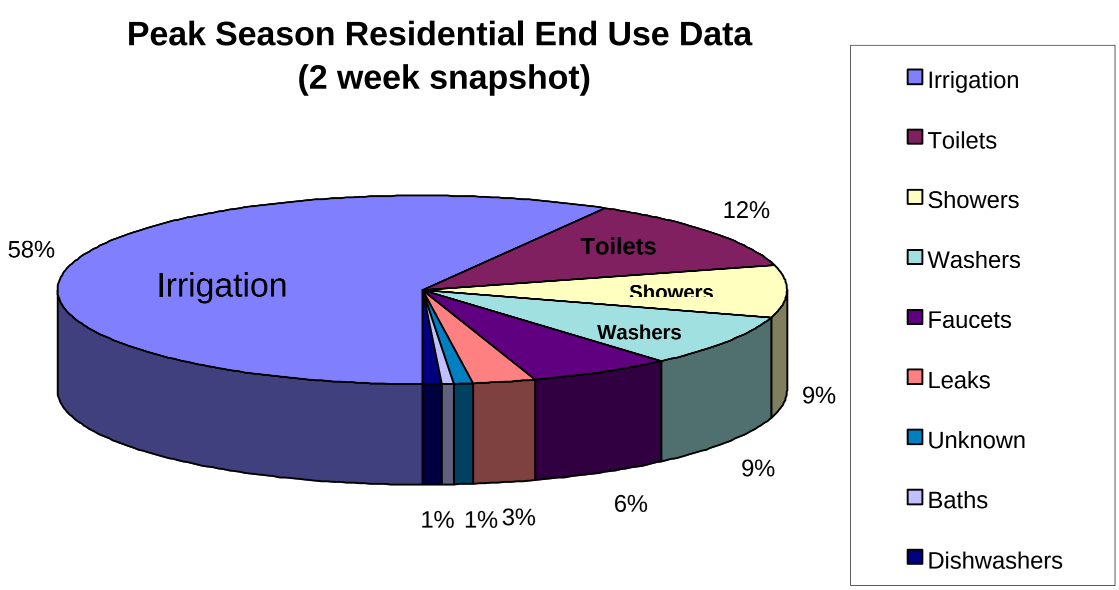


day, peak season, and annual average demands demand reductions have been achieved at a time when overall population served in the regional water system has been increasing. Changes in population and peak day consumption can be seen on the following graph. The region now serves approximately 20% more people, but peak day demand has been lowered by almost a third. As a result, some distribution and supply facility expansions



have been postponed, saving millions of dollars in debt service and helping to reduce short term rate increases. Other indirect benefits of peak demand reduction include O & M savings such as added operational flexibility in routing of flows in the distribution system, lower energy pumping costs, and some labor/overtime reductions.

Peak demands can be analyzed by many timeframes: yearly, seasonally, monthly, weekly, daily, and hourly, and even minute by minute. In Seattle, distribution facilities are typically designed using peak week demands, but each utility is different. Based on a random sample of residential customers, a data set has been developed based on peak use of specific end uses. This information provides insight into how customers use water. In the case of Seattle, most of the peak season demand is due to residential lawn watering, so detailed examination of how these customers use water is key to understanding peak use. Other utilities might want to concentrate similar efforts on commercial and industrial users, if they are major peak contributors. The following pie chart shows the



results of recording distinct end uses from ninety single family households for a two week period during the summer. For these 90 homes, water use during this two week period

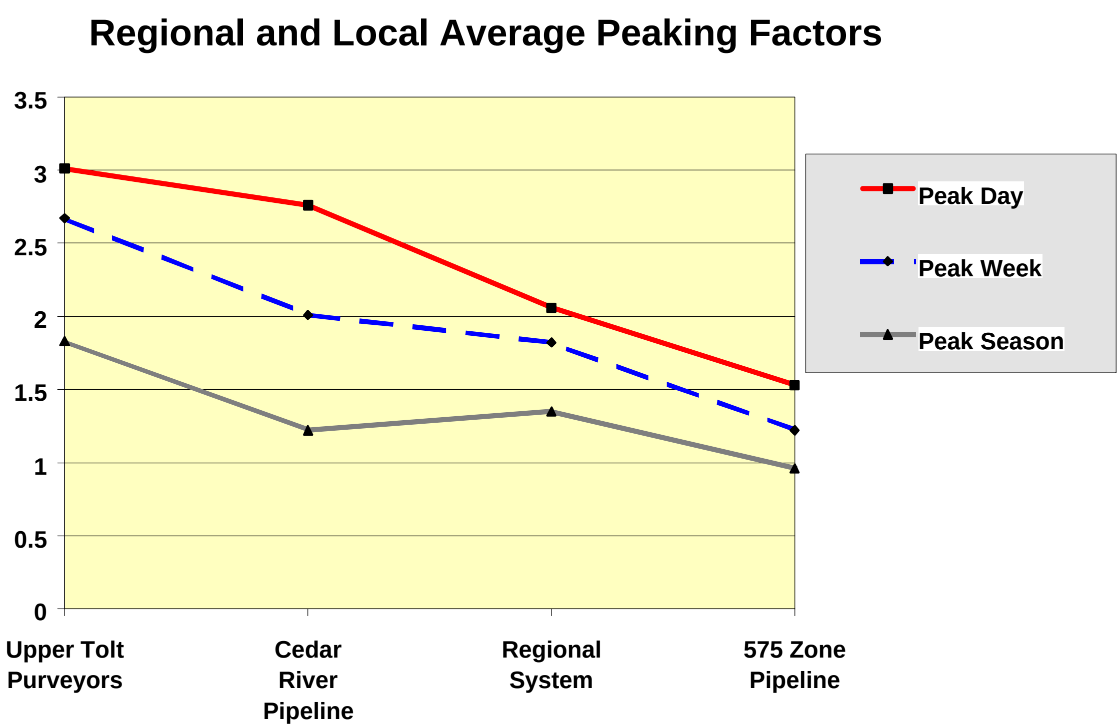
use was indoors. Unfortunately it was not possible to time the individual home measurements with the yearly high peak day event for the entire system. However, by

zones and large subdivisions every five minutes for an entire year, the data from individual households can be integrated to fine tune a system wide peak demand model.

term peaking factor or peak ratio is defined as:

$$\text{Peaking Factor} = \frac{\text{Peak demand}}{\text{Average demand for that year}}$$

Where the timeframe units can be adjusted (season, week, day, etc.). Looking at peaking factors for multiple years, a multi-year probability curve can be developed. In Seattle for example, there is a 10% probability that a peak day ratio of 2.06 would be exceeded in any year. For Seattle's system it has been determined that a 10% exceedence probability is a reasonable engineering design parameter. The graph below shows regional and local average peaking factors for the entire regional system and for selected sub-areas of the supply system, based



on this 10% probability factor. Note that the Upper Tolt purveyors have much higher peaking factors than the regional system. Customers in the Tolt area have estate type homes, with large irrigated lots of an acre or larger. In contrast, many of the homes in the 575 zone have small city lots and most customers irrigate only plantings and not their lawns.

An analysis of peak demand patterns has been conducted using billing records, zone metering, and residential end use metering. Other indirect benefits of peak demand reduction include O & M savings such as added operational flexibility in routing of flows in the distribution system, lower energy pumping costs, and some labor/overtime reductions

Peak Demand Reduction Strategies

The traditional approach to insuring that peak demand can be met is to enlarge storage

term pressure reduction. Among the strategies used to solve peak demand problems are:

- Increase storage and transmission capacity
  Provide more supply capacity
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- Other utility management options (deferrals)
  Customer demand reduction

The first three of these are typical utility responses. This paper will focus on other utility

Other Utility Options

Utilities can help themselves by avoiding discretionary water use during peak use times

uses of water from fire hydrants, including flushing and testing, can be scheduled for non-peak periods. Selected municipal uses, such as irrigation, street, and sewer cleaning, can

tool to help reduce peak demand. Demand Metering (seasonal or time of day metering) for example, can be established for large wholesale and industrial customers. Accelerated

important role in peak reduction.

Options Seattle Public Utilities uses for reducing peak demand include:

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  storage. This transfers the cost of meeting peak demand back to the customer.

  Large customers are assessed a demand charge of $21.10 per thousand gallons for exceeding daily flow volumes of 1.3 times their average use. This basically forces

- Use of artificial recharge wells and high rate pumping during peak season. Wells are

  much higher than normal during peak periods. This uses aquifers as peaking reservoirs, rather than pumpage rates based on long term well yield.
  Utility subsidizing of non-potable secondary supplies. In some cases, peak users such as golf courses, industrial cooling water, etc. can be encouraged to either use

  periods.
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  may wish to risk interruption for peak day or peak week in exchange for lower rates year-round. While common in electric utilities, interruptible rates are still rare among water utilities. Seattle has considered, but not adopted, interruptible rates.

- Peak day scheduling of large peak users. Utilities can sometimes request selected customers to hold back consumption if the utility anticipates a high peak day or peak week use.
- Selected water use restrictions. Bans on irrigation based on time of day, day of week, etc. are often done to avoid water shortages, but also can be effective in reducing peak demands.

Customer Demand Reduction

Price is an excellent tool for controlling peak demand. Seattle has adopted a peak season rate that makes water during the four summer months 1.5 to 2.6 times more expensive (price depends upon customer class). Water surcharges can be applied during periods of shortages or high peak demands on top of existing rates. Water waste patrols and water theft fines have been used effectively but selectively during shortages. Some utilities also link water use to sewer charges, which can provide additional price incentives during peak season. Linkage of rates to the marginal cost of water during peak demand periods can provide further customer incentives to become more water efficient. Increased meter reading and billing frequencies, and utility watch billing services, all help keep customers alert to the importance of peak demand reduction to them.

Other price related measures, not applied in Seattle, include system development fees that target peak users. These include measures like hook-up or meter base charges calculated on irrigated lot size or square footage. Some water utilities have higher rates for elevated pressure zones, for example, to help cover the increased cost of pumping and storage. Frequent meter reading and billing can allow more flexibility in rate setting to address peaking issues.

In Seattle peak demand is dominated by landscape water use measures because of our "summer demand crunch". Landscape measures include a summer campaign media coverage (TV, radio, print media) to influence lawn water behavior, demo gardens, workshops and speaker tours, direct mailings and bill inserts, short messages on water bills including printed consumption histories, and zoning and landscape codes. Financial incentives for industrial and commercial customers are weighted to maximize rebate levels for peak season uses such as cooling towers, food processing, ice production, and commercial irrigation.

Seattle Public Utilities includes both distribution and source of supply costs in calculation of per CCF marginal cost. Examples of incremental cost for providing an additional CCF of maximum peak demand include:

Item	***$ per CCF***
▪ Pumping and related equipment	1.32
▪ Purification Equipment	1.12

▪ Land Acquisition	0.92
▪ O &M and Misc. Adm.	0.74
▪ Reservoirs and Standpipes	8.08
▪ Transmission Pipelines	6.81
▪ Telemetry and Metering	5.73

These distribution costs, along with the cost of supply and other costs, can be rolled together for the most likely expansion projects, so that average marginal cost numbers can be obtained. In Seattle, the total average marginal costs are:

$16.27 per CCF for Peak Day
$ 9.43 per CCF for Peak Week
$ 0.97 per CCF for Peak Season
$ 0.22 per CCF for Average Annual

Cost calculations are used both in establishing marginal cost rates and in setting maximum financial incentive levels for cost sharing with customers in demand management activities. For example, peak season rates for commercial customers are now at $1.77 per CCF. For customers that are eligible to participate in Seattle's cost sharing for water conservation incentives, installed project rebates are offered at $2.41 per CCF for peak season demand reductions, for up to half the total project cost. Rebates at this level are possible because the utility values peak water savings much higher than yearly average water savings.

Summary

Seattle has made good progress in reducing peak demand over the past decade. Several techniques that have worked best for Seattle are:

- Marginal cost pricing rate structures for all customer classes;
- Demand metering charges to send additional price signals to "peaky" customers;
- Reduction in non-revenue water by timing flushing, reservoir cleaning, and overflows; and,
- A highly visible, award winning, public information "conservation" campaign that focuses on lawn watering efficiency, using TV, radio, and print media, as well as traditional bill inserts.

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